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CENTRAL INTELLIGENCE AGENCY

C-O-N-F-I-D-E-N-T-I-A-L

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SOURCE EVALUATIONS ARE DEFINITIVE. APPRAISAL OF CONTENT IS TENTATIVE.

[redacted] Hungarian road construction specifications, standards, and procedures and includes sketches of various types of road construction and concrete pavements.

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ARMY review completed.

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STATE	#X	ARMY	#X	NAVY	X	AIR	#X	FBI		AEC				

(Note: Washington distribution indicated by "X"; Field distribution by "#".)

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HUNGARIAN ROAD CONSTRUCTION SPECIFICATIONS, STANDARDS, AND PROCEDURES (C)

[redacted]

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Summary: This report contains information on Hungarian road construction specifications, standards, and procedures. Included are data on construction specifications, standards, and procedures for macadam roads, stone and brick roads, black top roads, concrete roads, and stabilized base courses; specifications and standards for curves, drainage ditches and pipes, shoulders, grade crossings and road crossings; sources and availability of aggregate and base construction materials. [redacted] comments on construction equipment, the highway numbering system, Soviet control in highway construction, and the Hungarian Research and Development Institute for Highway Construction (Útügy Kutató Intézet - UKI).

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HUNGARIAN ROAD CONSTRUCTION SPECIFICATIONS, STANDARDS, AND PROCEDURES (C)

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HUNGARIAN ROAD CONSTRUCTION SPECIFICATIONS, STANDARDS, AND PROCEDURES (C)

Introduction

This report contains [redacted] information on Hungarian road construction, specifications, standards, and procedures. [redacted] Hungarian road specifications and standards manuals [redacted] were adopted in 1951 by the Ministry of Post and Transporation (Közlekedes es Postaugyi Miniszterium) in BUDAPEST, and published in 1951 by the Transportation Press of the Ministry of Post and Transportation (Közlekedésügyi Miniszterium, Közlekedés Kiadó) in BUDAPEST; [redacted] There were three volumes of the Hungarian road specifications and standards manuals, each of 80 to 120 pages, each was approximately 25 x 30 cm, and each was bound in a grayish, pressed-paper cover. [redacted] it was mandatory that the specifications and standards contained in these manuals be adhered to. [redacted]

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The following is a list of locations referred to in this report, with coordinates for each:

Location	Geographic Coordinates	UTM Coordinates
BADACSONYTOMAJ	N46-48, E17-31	XM-9286
DISZEL	N46-53, E17-30	XM-9095
DUNABOGDÁNY	N47-47, E19-02	CT-5396
ERDŐBÉNYE	N48-14, E21-20	EU-2445
FELSŐGALLA	N47-32, E18-26	CT-0769
HEJŐCSÁBA	N48-04, E20-47	DU-8424
HOSSZUHETENY	N46-09, E18-20	BS-9515
KOMLÓ	N46-11, E18-15	BS-8919
LESENCEISTVÁND	N46-52, E17-21	XM-8093
NEMESGULÁCS	N46-52, E17-29	XM-8990
NYIREGYHÁZA	N47-58, E21-43	EU-5411
PÉCS	N46-05, E18-13	BS-8605
SOMOSKŐUJFALU	N48-10, E19-49	DU-1235
SOPRON	N47-41, E16-35	XN-1982
SÜMEG	N46-58, E17-17	XN-7305
SZANDA	N47-55, E19-29	CU-8309
SZARVASKŐ	N47-59, E20-20	DU-4915
SZOB	N47-49, E18-52	CT-4098
TARCAL	N48-08, E21-20	EU-2631

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Location	Geographic Coordinates	UTM Coordinates
TÁLLYA	N48-14, E21-40	EU-1743
TINNYE	N47-37, E18-46	CT-3376
TOKAJ	N48-07, E21-24	EU-3030
USZA PUSZTA	N46-54, E17-20	XM-7898
VÁC	N47-46, E19-08	CT-6093
VESZPRÉM - CSERERDO	N47-07, E17-52	YN-1824
VILLÁNY	N45-52, E18-27	CR-0282
VISEGRÁD	N47-47, E18-58	CT-4894
ZALAHALÁP	N46-54, E17-27	XM-8898

1. Macadam Roads (See Annex A for sketch.)

Macadam served as the base or wearing course of approximately 80 percent of the roads in Hungary. The roadway of macadam roads was 7 m wide; their wearing courses were 4 m wide, and their shoulders were 1.5 m wide. The slope of the crown was three percent; that of the shoulders, five percent. The cost of constructing these roads depended on the terrain, and varied from 400,000 to 500,000 forints per kilometer.

The excavation down to the subbase was performed by manual labor; it was dug to two-thirds of the intended thickness of the road. The excavated earth was piled evenly on both sides; this was later rolled forming the shoulders. Temporary lateral drainage channels were dug at intervals of 10 m; these were only to serve during the construction of the road. The surface of the excavation was rolled after the digging was completed. The base course consisted of two layers; both were laid by dump trucks. The first layer was of crushed basaltic rocks 17 to 20 cm in diameter. The gaps between these rocks were closed by forcing stones into them. This layer was rolled 10 to 12 times with a steam or diesel roller (weight 10 to 25 tons). The second layer was of smaller crushed rocks 4 to 6 cm in diameter; it was rolled 12 times. The third layer was four centimeters thick and consisted of crushed stones one centimeter in diameter. Each cubic meter of this stone was mixed with three-tenths to five-tenths cubic meters of water. The wearing course was rolled approximately 90 times; it was rolled until the weight of the roller no longer left marks in it or until a test stone could not be forced into it. After it had been sufficiently rolled and was ready for use, a 2-centimeter-thick layer of gravel (5 to 15 mm in diameter) was applied.

2. Stone and Brick Roads

Approximately 90 percent of the urban roads were of stone or brick. The base course of these roads was the same as that of the macadam roads. The stones or bricks of the wearing course were laid on a bed of sand, bitumen, or asphalt. Most of these pavements were of basalt bricks which came in two sizes, 18 x 18 x 18 cm and 18 x 18 x 13 cm, weighing 18 and 15 kg respectively. The next most frequently used were slag bricks. These came in various sizes and were black. They were molded at a temperature of 1,400°C. Ceramic bricks were made in brick kilns upon special orders; these were used for grade crossings and for pavements which required a higher degree of cleanliness such as those in front of dairies. Basalt and andesite cobblestones were used on grades of five percent or more. Their sizes varied from 6 x 8 x 4 to 10 x 10 x 6 cm. The Sinus pattern was usually followed in laying cobblestone pavements.

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3. Black Top Roads

Hungary had no natural bituminous resources. Small quantities were imported from Rumania and Czechoslovakia; the rest - including bitumen, liquid bitumen, tar, cold tar, black tar (szűrök), and emulsion tar - were produced as derivatives of oil or coal. Sufficient quantities of these products could be produced in this manner, and the cost of producing them was not prohibitive.

The following were the types of bituminous wearing courses common in Hungary.

a. Tar Surfaced Roads (See Annex B, Figure 1 for sketch.)

On a macadam base course 25 cm thick, 2 kg per square meter of tar at 100° to 120°C was sprayed by a pneumatic device. A 1 to 1.5 cm thick layer of crushed stones 10 to 15 mm in diameter was laid on top of this, and rolled several times by a 3- to 6-ton roller. Two or 3 months later the road was again sprayed with 1 to 1.2 kg of tar per square meter. A one-centimeter-thick layer of crushed rocks was laid on top of this and the road was rolled eight times.

b. Bitumen Surfaced Roads (See Annex B, Figure 2 for sketch.)

Tar, .7 to 1 kg per square meter, was sprayed onto a 25-centimeter-thick macadam base course. Four to five kilograms of crushed stones per square meter were spread on top of the tar. Eight hours later, 1.5 kg of bitumen per square meter, at 160° to 180°C or 80° to 90°C (cold bitumen), was sprayed on. A 1.5-centimeter-thick layer of crushed stones 10 to 15 mm in diameter was laid on top of this, and the road was rolled several times by a light rubber roller. Two to three months later, the road was cleaned with pneumatic blowers, and one kilogram of bitumen per square meter was sprayed on it. A 1-centimeter-thick layer of crushed stones 10 to 15 mm in diameter was laid on top of the bitumen and the road was rolled by light rollers.

c. Emulsive Bituminous Surfaced Roads

An emulsive bituminous wearing course was applied to roads whose location would have made transporting and setting up tar or bitumen heating facilities very expensive. This was an emulsion of bitumen, water, and a soap binder whose chemical composition was a secret.

d. Tar-Bitumen Surfaced Roads (See Annex B, Figure 3 for sketch.)

This process was usually applied in the repair of macadam roads. Two kilograms per square meter of tar was sprayed onto a 25-centimeter-thick macadam base course. A 1.5 to 2 cm thick layer of crushed stones 5 to 10 mm in diameter was laid on top of this, and the road was rolled by a three-ton roller. After 2 to 3 months of traffic, the road was sprayed with 1.5 kg per square meter of bitumen at 160° to 180°C, and a 1.5 to 2 cm thick layer of crushed stones 10 to 15 mm in diameter was applied.

e. Roads Surfaced by the Impregnation Process

This process was used in laying wearing courses on new or old macadam base courses. There were two impregnation processes: the semi- and the complete impregnation.

(1) Semi-Impregnation Process (See Annex C, Figure 1 for sketch.)

A 2- to 3-centimeter-thick layer of sand was laid onto a macadam base course 25 cm thick; this was followed by laying a 6- to 9-centimeter-thick layer of crushed rock, 70 to 80 percent of which was 40 to 65 mm in diameter and

20 to 30 percent of which was 25 to 35 mm in diameter. This was rolled until solid by a 10-ton roller. Four to five kilograms per square meter of bituminous binder was then applied, and the road was rolled by a three-ton roller.

(2) Complete Impregnation Process (See Annex C, Figure 2 for sketch.)

For each centimeter of the 25-centimeter-thick macadam base course, .5 to .7 kg per square meter of tar was sprayed; this was followed by laying a 6- to 9-centimeter-thick layer of crushed rock, 70 to 80 percent of which was 40 to 65 mm in diameter and 20 to 30 percent of which was 25 to 35 mm in diameter. A .6-centimeter-thick layer of bitumen .8 to 1.2 kg per square meter at 160° to 180°C was sprayed on top of this. A 1- to 1.5-centimeter-thick layer of crushed stone 15 to 25 mm in diameter was laid on top of this and the road was rolled until compact. Three months later, a .4-centimeter-thick layer of bitumen .8 to 1.2 kg per square meter at 160° to 180°C was sprayed on. This was covered with a layer of crushed stone 5 to 15 mm in diameter and the road was rolled.

f. Asphalt Surfaced Roads

Three types of asphalt wearing courses were laid in Hungary: (1) sheet asphalt, (2) fine asphalt-concrete (Topeka), (3) rough asphalt-concrete (Bitumac). All three were laid at 100° to 120°C.

(1) Sheet Asphalt Wearing Courses

This type was laid on grades of 2.5 percent or less. A mixture of 100 kg of fine natural or crushed sand (3 mm or less in diameter) with 8 to 9 kg of asphalt was laid to a thickness of 4 to 6 cm on a macadam or concrete base course. This was mixed by an electric mixer.

(2) Fine Asphalt-Concrete Wearing Courses (Topeka)

The fine asphalt-concrete (also known officially as "Topeka") wearing course was a mixture of 100 kg of powdered rock and gravel and 7 to 9 kg of bitumen. This was laid to a thickness of three centimeters on a macadam or concrete base course. This type was usually laid on urban roads where there were grades of five percent or less.

(3) Rough Asphalt-Concrete Wearing Courses (Bitumac)

The rough asphalt-concrete (also known officially as "Bitumac") wearing course was a mixture of 100 kg of gravel and crushed rocks (whose diameters were not to be greater than two-thirds of the intended thickness of the wearing course), and 6 to 7.5 kg of bitumen. The base course was usually macadam. This type was the cheapest of the three surfaces to lay and had a high braking factor.

4. <u>Concrete Roads</u>

As of 1957 there were 1,000 km of concrete roads in Hungary; these included both Class I and Class II roads. Based on past experience the cost of constructing concrete roads was 2,000,000 Forints per kilometer; this cost included bridges and took into consideration unfavorable terrain. Cement for road construction was readily available. Three domestic types were used: C400, C500, and C600; the last was the best quality and was used primarily for structural bridge work and for airfield runway construction. [redacted] even C600 was of poor quality as 25X1
compared with the cements of western countries. Portland cement was not available in Hungary; however, C600 was a cement similar to it and was called "portland cement."

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cement was manufactured in HEJÓCSÁBA, FELSŐGALLA and VÁC. The quality of the cement was controlled by the Hungarian National Standard (Magyar Népköztársaság Országos Szabvány - MNOSZ).

a. Concrete on Macadam Base Course

There were four types of concrete pavements built on a macadam base course: Type 1 (For sketch see Annex D, Figure 1) was developed in 1929; Type 2 (For sketch see Annex D, Figure 2) in 1930 to 1933; Type 3 (See Annex D, Figure 3) in 1935; Type 4 (See Annex D, Figure 4) in 1940. All four were still being used in new road construction. The capacity of Type 1 and 2 pavements was 10 tons; that of Types 3 and 4 was 24 tons. The weight of Types 1 through 3 was 1,850 kg per cubic meter; 350 of which was portland cement (C600); 1500 of which was a mixture of sand 5 mm in diameter, and crushed stones 5 mm to 25 mm in diameter. The weight of type 4 was 1,800 to 1850 kg per cubic meter; 300 to 350 of which was portland cement (C600); 1500 of which was a mixture of sand 5 mm in diameter and crushed stones 5 mm to 25 mm in diameter. The thicknesses of the pavements were .15 m, .13 m, .12 m, and .13 m respectively. Types 1, 2, and 4 were thickened edge type pavements; the edge thicknesses were .22 m, .18 m, and .18 m respectively; the thickening was accomplished in the outer .6 m of the pavement.

b. Concrete on Fill

Three types of concrete pavements were laid on fill covered with insulation paper (see Annex E, Figures 1, 2, and 3). These were developed after World War II and had capacities of 24 tons. The fill for these roads had to be of sandy composition and the soil had to have a subbase bearing strength of .7 kg per square centimeter. The weight of Type 5 pavement was 1,850 kg per cubic meter; 350 of which was portland cement (C600); 1500 of which was a mixture of gravel 5 mm to 25 mm in diameter. This was a thickened edge type pavement; the center thickness was .18 m, the edge thickness .22 m; the thickening was accomplished in the outer .6 m of the pavement. The slope of its crown was 1.5 to 2 percent. The weight of Type 6 pavement was 1,800 kg per cubic meter; 300 of which was portland cement; 1,500 of which was aggregate of the same composition as that of Type 5. Its thickness was .18 m and uniform. Type 7 pavement consisted of two layers. The weight and composition of the top layer were the same as those of Type 5. The weight of the cement of the base layer was only 250 kg per cubic meter; the aggregate weight and composition of this layer was the same as that of Type 5. The thickness of the top layer was .05 m and uniform; that of the base layer was .10 m and uniform.

c. Miscellaneous Information on Construction of Concrete Roads

(1) Joint Fillers and Steel Dowels

The transverse and longitudinal expansion joints were one centimeter wide and filled with a bituminous joint filler (See Annex F, Figures 1 and 2). The maximum allowable area between expansions joints was 25 to 30 square meters. Steel dowels were embedded in the concrete across the joints (See Annex F, Figure 3).

(2) Curing of Concrete

Concrete pavements were cured for 10 days by being covered with straw and continuously sprinkled with water.

(3) Concrete Pavement Field Tests and Test Molds

After the pavement had been cured for 5 to 24 hours, two samples 20 x 20 x 70 cm each were extracted from the pavement. After 6 weeks these two samples were tested for modulus of rupture (hajlitásbol származó húzóigénybevétel).

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Requirements established for a 6 week modulus of rupture were 45 kg sq m.

After one week and again after 6 weeks, test molds prepared from the actual field mix were tested for compressive strength and modulus of rupture. Compressive strength requirements for 1 week were 350 kg per sq m; for six weeks they were 450 kg per sq m. Modulus of rupture requirements for 1 week were 35 kg per sq m; for six weeks they were 45 kg per sq m.

Test molds, prepared from the actual field mix used in the construction of the decks of concrete bridges, were tested after 10 and 28 days for compressive strength and modulus of rupture. Compressive strength requirements established were from 150 to 600 kg per sq cm. The requirements established for modulus of rupture varied with the sections of the bridge.

5. Stabilized Base Courses

Soil stabilizing was required in areas where it was necessary to prevent frost heave or where the subgrade bearing strength of the soil was less than .7 kg per sq cm. Common admixtures applied to stabilized surfaces were bituminous materials, gravel, slag, and cement.

[redacted] construction of a stabilized base course for a concrete highway (for sketch see Annex G). The subbase was 25 to 40 cm thick and consisted of a mixture of sand and earth. This was rolled several times by a three to five ton roller. The slope of the subbase from the center of the road to a distance of 3 m from the center was 2.5 percent; from there to the ditch, it was 4 percent. The stabilized base course was 15 cm thick and of C500 cement 12 kg per sq m. The wearing course was 18 cm thick and of concrete. The slope of the crown was 1.5 percent; that of the improved fill shoulders, 3 percent; that of the fill shoulders, 5 percent. 25X1

6. Curves

a. Classification of Highways with Respect to Speed of Traffic

[redacted] all roads in Hungary were constructed to accommodate traffic moving up to a certain speed. As an aid in accomplishing this, all roads were placed into one of three categories during the planning phase. This category indicated the proposed speed of traffic on the road, and facilitated the determination of such things as the superelevations and radii of the road's curves, its field of view and its width. These designations were used only by the planning agency of UVATERV, and are not to be confused with the Class designation of Hungarian highways. The following were the traffic speed limits over various types of terrain for which the categories of roads were to be built. 25X1

Category	Speed		
	Level Terrain	Rolling Terrain	Mountainous Terrain
I	120 kmph	80 kmph	50 kmph
II	100 kmph	60 kmph	40 kmph
III	80 kmph	40 kmph	30 kmph

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b. Minimum Radii of Curves

The following were the minimum radii of curves on various types of terrain for the three categories.

Category	Minimum Radii		
	Level Terrain	Rolling Terrain	Mountainous Terrain
I	600 m	250 m	100 m
II	400 m	150 m	170 m
III	250 m	70 m	30 m

On main highways it was prohibited to construct curves whose radii were less than 200 m; curves whose radii were 50 m and occasionally even 30 m could be constructed on lower class roads. Any curve whose radii were less than 800 m had to be constructed as a spiral transition curve.

c. Minimum Lengths of Curves as Determined by Minimum Radii and Traffic Speed

The following were the minimum lengths allowed for curves having the minimum radii indicated and being in roads whose traffic speed was 100 kmph or 120 kmph.

Traffic Speed 120 kmph		Traffic Speed 100 kmph	
Minimum Radii	Minimum Length	Minimum Radii	Minimum Length
600 m	160 m	400 m	120 m
700 m	130 m	500 m	97 m
800 m	112 m	600 m	80 m
900 m	110 m	700 m	70 m
1000 m	90 m	800 m	60 m

d. Superelevation

The following table shows the degree to which the pavements were sloped or banked to counteract the centrifugal force of a moving vehicle on curves whose radii were as indicated.

Radii of Curve	Superelevation
100 m or less	8 percent
101 m to 150 m	7 percent
151 m to 200 m	6 percent
201 m to 300 m	5 percent
301 m to 500 m	4 percent
500 m to 1000 m	3 percent
1000 m to 2000 m	2.5 percent

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e. Widening of Roads at Curves

Roads were not widened at curves whose radii were greater than 200 m. In mountainous terrain the added width was divided between the inside and the outside. The following table shows the widths to be added at curves whose radii were as indicated.

Radii of Curve	Width To Be Added
20 m	1.7 to 2.2 m
30 m	1.4 to 1.9 m
40 m	1.2 to 1.7 m
41-60 m	1.0 to 1.4 m
61-80 m	0.8 to 1.2 m
81-100 m	0.7 to 1.0 m
150-200 m	0.5 m

f. Vertical Curves

The following table shows the minimum radii of vertical curves in meters; these radii were computed on the basis of the longest type wheeled vehicle used in Hungary, which was the land train or the van with the trailer combination.

Type of Curve	Type of terrain and Class of Highway								
	Level Terrain			Rolling Terrain			Mountainous Terrain		
	I	II	III	I	II	III	I	II	III
Convex	6,000	3,000	2,500	2,500	1,000	600	800	600	400
Concave	3,000	2,000	1,500	1,500	600	500	600	500	400

7. Highway Drainage

a. Side Drainage (See Annex H, Figure 1 and 2 for sketch.)

All roads required side drainage; the ditch runoff system was used. Where roads had no grades greater than 3 percent, there were earth ditches whose sides sloped outward at a ratio of 6:4. Where there were grades greater than 3 percent, the ditches were lined with 20 cm cobblestones whose joints were filled with bitumen and which were laid on a 10 cm thick layer of sand. The sides of these ditches sloped outward at a ratio of 1:1. The width of the bottoms of ditches varied from 40 to 50 cm.

b. Lateral Drainage

Lateral drainage was accomplished by culverts made of concrete pipes (see Annex H, Figures 3 and 4). The minimum cover was specified as 70 cm, and additional concrete encasement was required where the depth of cover was shallower. The pipes most used were 10, 20, 30, 40, and 50 cm in diameter. They were manufactured in one meter lengths. For pipes whose diameters were 60 cm or larger, the sections were poured in place on the construction site.

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c. Slope of Crown

The slope required for crowns of concrete highways was 1.5 to 2 percent; for crowns of asphalt highways, 2.5 percent; for crowns of macadam highways, 3 to 3.5 percent.

8. Shoulders

Three types of shoulders were constructed on roads in Hungary. On Class III roads, where grades were less than three percent, the shoulders were of natural fill and two meters wide. All other shoulders were 1.5 m wide. The slopes of all shoulders were five to six percent.

a. Rolled Natural Fill Shoulders

These shoulders were of fill which was excavated in building the road, and were rolled. They were constructed wherever conditions were normal: where there were no grades greater than 3 percent; where the subbase bearing strength of the soil was 0.7 kg per sq cm or greater; where the traffic was normal; and in other than urban areas.

b. Cobblestone Shoulders

These shoulders consisted of a 25 cm thick layer of cobblestones (compressive strength 1,500 to 2,000 kg per sq cm) whose joints were filled with hot bitumen, and which were laid on a 10 cm thick base of sand and stone. They were constructed in urban areas, and in rural areas where the traffic was heavy or the grades were greater than three percent.

c. Rolled Improved Fill Shoulders

These shoulders were constructed wherever the subbase bearing strength of the soil was less than 0.7 kg per sq cm. They were 30 cm thick and consisted of a mixture of fill and gravel. They were layed in several layers; each layer was rolled.

9. Grade Crossings and Road Crossings

a. Grade Crossings

At grade crossings the maximum allowable angle of approach of the highway to the railroad was 45 degrees. The highway approaches had to be level with the center of the tracks for a distance of 25 m on both sides.

b. Road Crossings

Appropriate warning signs were to be placed at all road crossings. The manual for Hungarian road specifications and standards listed three types of road crossings.

(1) Crossings of a Main and a Secondary Road

(a) Type 1

The secondary road approaches were paved with cobblestones for 25 m. The purpose of this was to prevent carrying earth from the secondary road onto the main road. The secondary road approaches were to be wide enough to permit gradual entry with good visibility onto the main road.

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(b) Type 2

Median isles were to be built into the approaches of the secondary road. Just as with Type 1, the secondary road approaches were to be paved with cobblestones and wide enough to permit gradual entry with good visibility onto the main road.

(2) Type 3, Crossings of Two Main Roads

Traffic circles were recommended at crossings of two main highways; they were particularly recommended where more than two main roads intersected.

10. Aggregate and Base Construction Materials

Stone and gravel materials were plentiful in Hungary. Most of the rock quarried was basalt or andesite. A series of large quarry areas have been under construction in the SÜMEG-LESENCEISTVÁND sector since 1950. As of 1958 this work had not been completed. The planned production of these quarries was to be 20,000 metric tons per day of materials having a compressive strength of 3,100 kg per sq cm. The following quarries had construction materials with a compressive strength of 1,500 kg per sq cm or greater.

Quarry Location	Type of Rock	Compressive Strength kg/cm^2	Crushing Facilities
BADACSONYTOMAJ	Basalt	2000-3000	Yes
DISZEL	Basalt	2600-4000	Yes
DUNABOGDÁNY	Andesite	1000-2000	No
ERDŐBÉNYE	Andesite	3140	Yes
HOSSZUHETENY	Phonolite	1600-3400	Yes
KOMLÓ	Pyroxene-Andesite	2500-3100	Yes
NEMESGULÁCS	Basalt	2600-3000	Yes
PÉCS	Lime	1800	No
SOMOSKŐUJFALU	Basalt	2600-3800	Yes
SÜMEG	Basalt	3100	No
SZANDA	Pyroxene-Andesite	2600	No
SZARVASKO	Diabase	1600-3000	No
SZOB	Andesite	2550	Yes
TARCAL	Andesite	1900-2700	No
TÁLLYA	Andesite	2700-3500	No
TINNYE	Lime	1500	No
TOKAJ	Andesite	2500-2800	Yes
UZSA PUSZTA	Basalt	1500	Yes
VESZPREM-CZERERDO	Dolomite		No
VILLANY	Lime	1800-2000	No
VISEGRAD	Andesite	1400-1800	No
ZALAHALÁP	Basalt	2000	Yes

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11. Construction Equipment

[redacted] 25X1 Most of the highway construction equipment used in Hungary was manufactured before 1949; the greatest part was imported from Western Countries. [redacted] 30 percent of the earthworking operations were carried out by machines and 70 percent by manual labor; and that 80 percent of the pavement work was done by machines and 20 percent by manual labor. 25X1

12. Highway Numbering System

Most of the roads in Hungary were posted with identification numerals. On Class I roads these signs were enclosed in a shield (see Annex I, Figure 1). Class I roads were main highways and were numbered from 1 through 8. On Class II and III roads the numerical designations were painted without shields on concrete posts (see Annex I, Figure 2). Class II roads were secondary highways and were numbered with two digits; the first digit indicated the Class I highway from which this secondary road branched. Class III roads were local roads and were numbered with three digits. Those roads which ran between secondary roads and local roads or between two villages had no numerical designations, and were known by the names of the villages they connected.

13. Soviet Control in Highway Construction in Hungary

The Soviets exerted influence at the ministerial level where priorities of work and specific projects to be initiated were determined. There seemed to be no doubt that the determination of whether or not a road was to be built in a certain area of the country was governed by Soviet strategic requirements.

14. Hungarian Research and Development Institute for Highway Construction (Útügy Kutató Intezét - UKI)

[redacted] It was located in BUDAPEST on Dimitroff Ter. No unusual activities were being carried out in this institute. It performed traffic studies, built road test sections, offered expert advice to highway planners, and similar type work. 25X1

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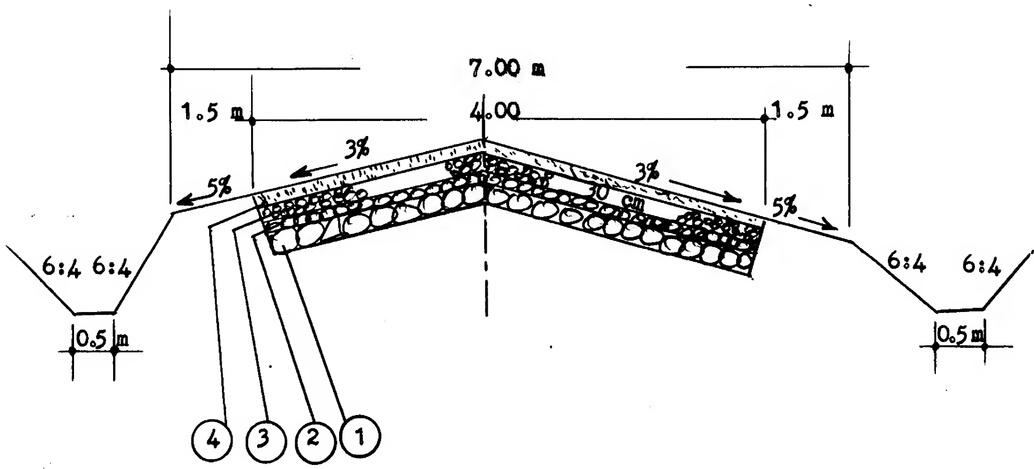
Annex A

[redacted] SKETCH OF MACADAM ROAD CONSTRUCTION (CROSS-SECTION) 25X1

[redacted] 25X1



Legend:

1. Twenty centimeter layer of crushed basaltic rocks (17 to 20 cm in diameter)
2. Six centimeter layer of crushed rocks (4 to 6 cm in diameter)
3. Four centimeter layer of crushed stones (1 cm in diameter)
4. Two centimeter of gravel.

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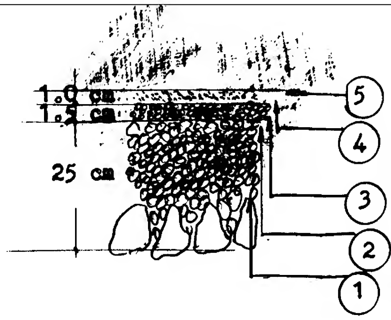
 [redacted] 25X1

Annex B

[redacted] SKETCH OF TAR, BITUMEN, AND TAR-BITUMEN SURFACED ROADS (CROSS-SECTION) 25X1

[redacted]



5 1 cm layer crushed stones, 5-10 mm diameter

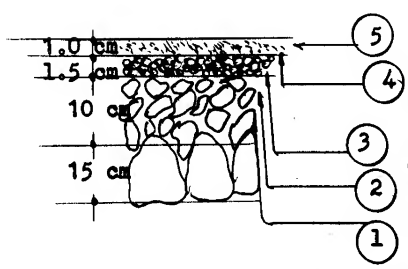
4 Tar, 1 to 1.2 kg per square meter, 2 to 3 months interval between first and second tarring.

3 1 to 1.5 cm crushed stones, 10-15 mm diameter.

2 Tar, 2 kg per square meter.

1 Macadam base course.

Figure 1 - Tar Surfaced Roads



5 1 cm crushed stones 5-10 or 10-15 mm diameter

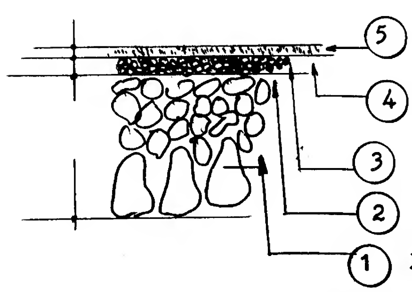
4 Bitumen, 1 kg per square meter, 2 to 3 month interval.

3 1 to 1.5 cm crushed stones 10-15 or 5-10 mm diameter

2 Bitumen, 1.5 kg per square meter.

1 Tar, 0.7 to 1.0 kg per square meter.

Figure 2 - Bitumen Surfaced Roads



5 1.5 to 2 cm crushed stones 10-15 mm diameter

4 Bitumen, 1.5 kg per square meter, 2 to 3 month interval.

3 1.5 to 2 cm crushed stones 5-10 mm diameter

2 Tar, 2 kg per square meter.

1 Macadam base course.

Figure 3 - Tar-Bitumen Surfaced Roads

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25X1

Annex C

25X1

SKETCH OF ROADS SURFACED BY THE IMPREGNATION PROCESS

Note: All dimensions are in centimeters.

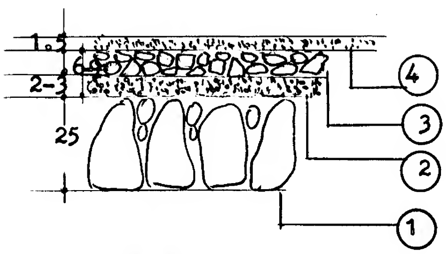
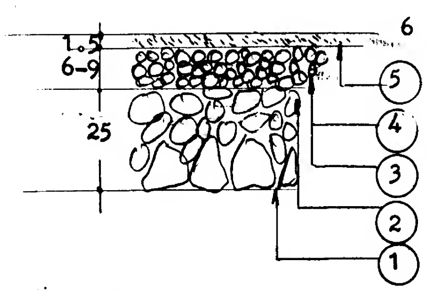


Figure 1 - Roads Surfaced by the Semi-Impregnation Process

1. Base course 25 cm thick
2. Sand 2 to 3 cm
3. Crushed stone 6 to 9 cm
4. Bituminous binder 4 to 5 kg per square meter



1. Macadam base course 25 cm thick
2. Tar, .5 to .7 kg per square meter
3. Crushed rock 6 to 9 cm thick
4. Six-tenths centimeter bitumen .8 to 1.2 kg per square meter
5. Crushed stone 1 to 1.5 cm thick, 2 to 3 month interval between processes
6. Four-tenths centimeter bitumen .8 to 1.2 kg per square meter covered with crushed rock.

Figure 2 - Roads Surfaced by the Complete-Impregnation Process

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25X1

Annex D

SKETCH OF TYPES OF CONCRETE PAVEMENTS ON MACADAM BASE COURSE 25X1

Note: All measurements are in meters.

25X1

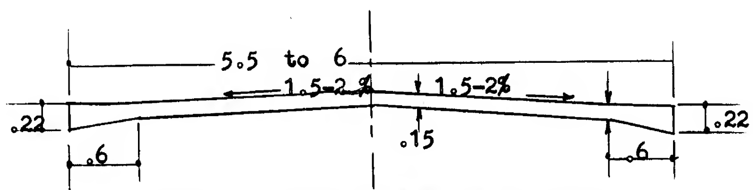

Figure 1 - Type 1, Developed in 1929

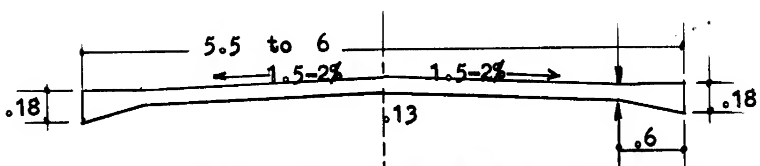

Figure 2 - Type 2, Developed in 1930 to 1933

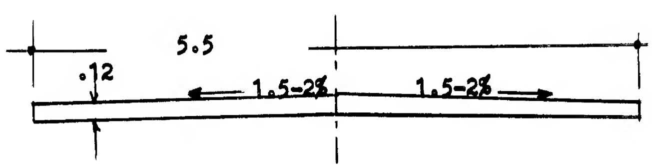

Figure 3 - Type 3, Developed in 1935

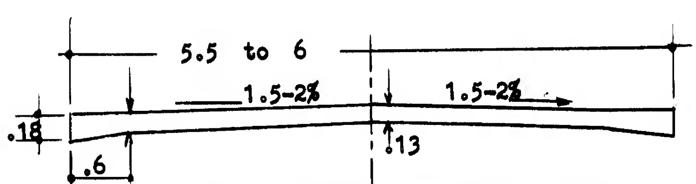

Figure 4 - Type 4, Developed in 1940

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[redacted] 25X1

Annex E

[redacted] SKETCH OF TYPES OF CONCRETE PAVEMENTS ON FILL 25X1

Note: All measurements are in meters.

[redacted] 25X1

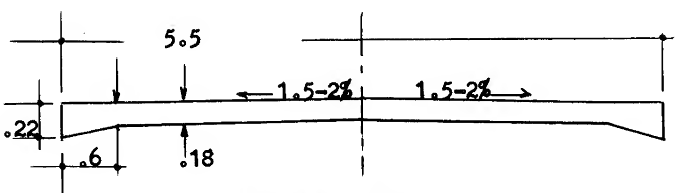

Figure 1 - Type 5

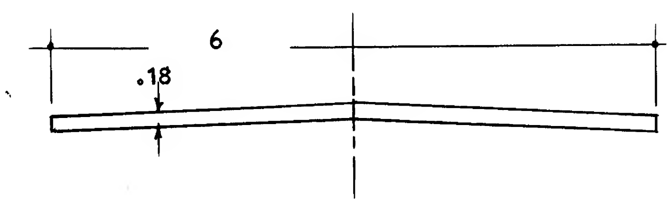

Figure 2 - Type 6

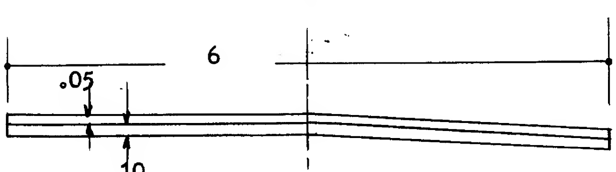

Figure 3 - Type 7

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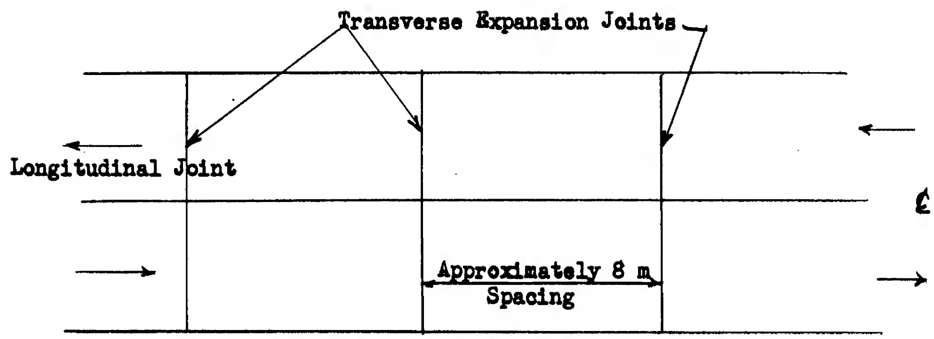
 [redacted] 25X1

Annex F

[redacted] SKETCH OF JOINT FILLERS AND STEEL DOWELS IN CONCRETE PAVEMENT 25X1

[redacted]



Joint Plan: Maximum allowable area between expansion joints: 25-30 sq m.

Figure 1 - Expansion Joints, Plan View

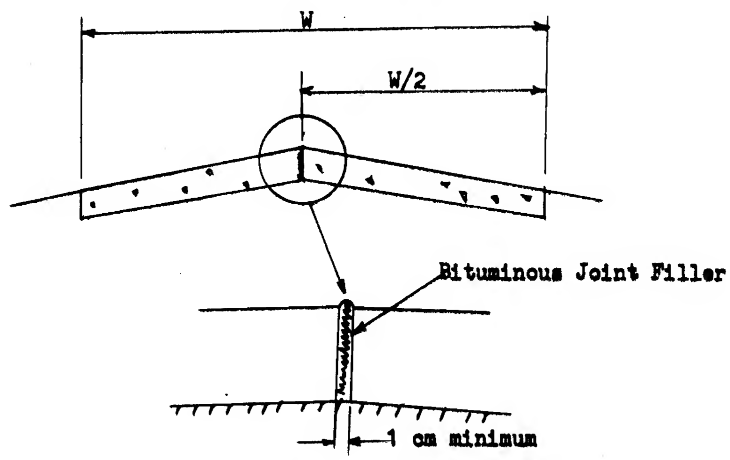


Figure 2 - Expansion Joints, Lateral Cross-Section

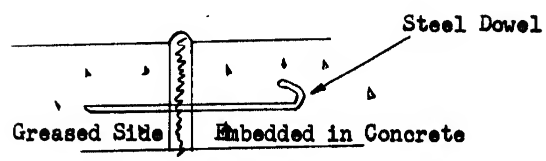


Figure 3 - Lateral Cross-Section Showing Steel Dowel

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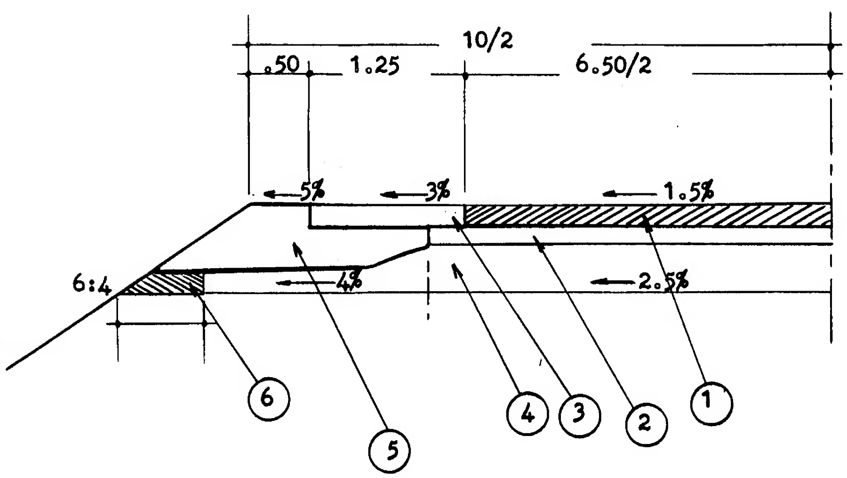
 [redacted] 25X1

Annex G

[redacted] SKETCH OF STABILIZED CONCRETE PAVEMENT 25X1
(All measurements are in meters.)

[redacted] 25X1



Legend:

1. Concrete wearing course, 18 cm thick.
2. Stabilized base course, 15 cm thick.
3. Improved fill shoulder.
4. Mixture of sand and fill, 25 to 40 cm thick.
5. Fill
6. Side bleeder drain, 50 cm wide.

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[redacted] 25X1

Annex H

[redacted] SKETCH OF DRAINAGE DITCHES AND PIPES 25X1

[redacted]

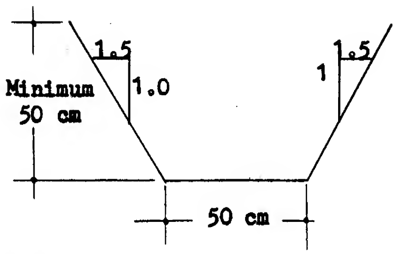

Figure 1 - Earth Drainage Ditch

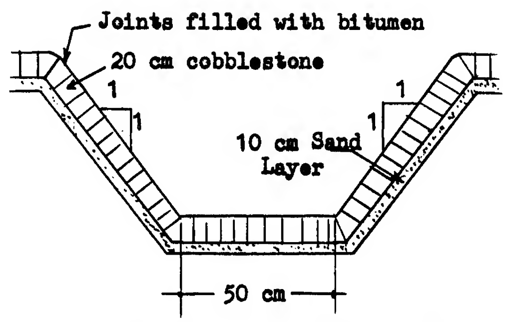

Figure 2 - Cobblestone Drainage Ditch

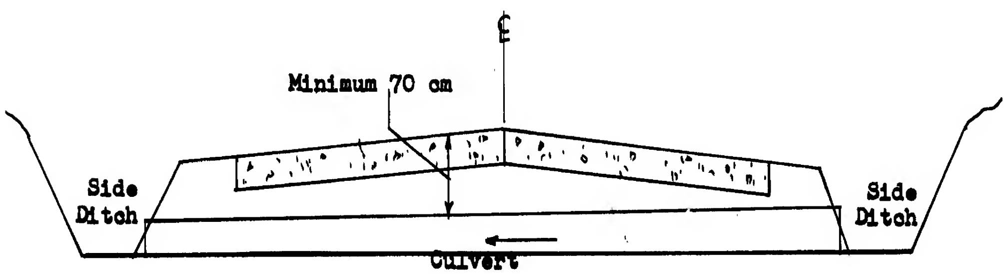

Figure 3 - Concrete Drainage Pipe, Cross-Section View

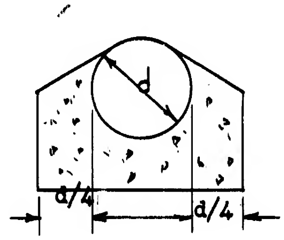

Figure 4 - Concrete Drainage Pipe, End View

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Annex I

[redacted] SKETCH OF HUNGARIAN ROAD SIGNS

25X1

[redacted]

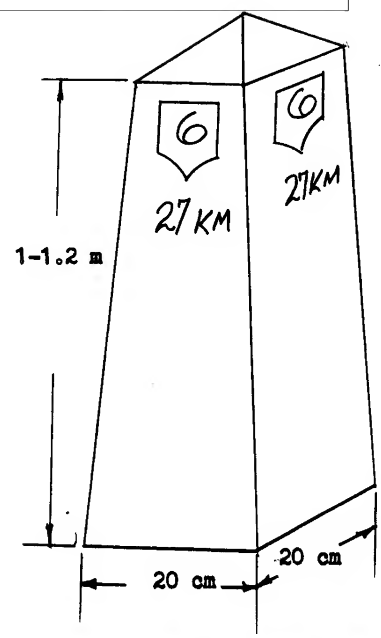

Figure 1 - Road Signs on Class I Roads

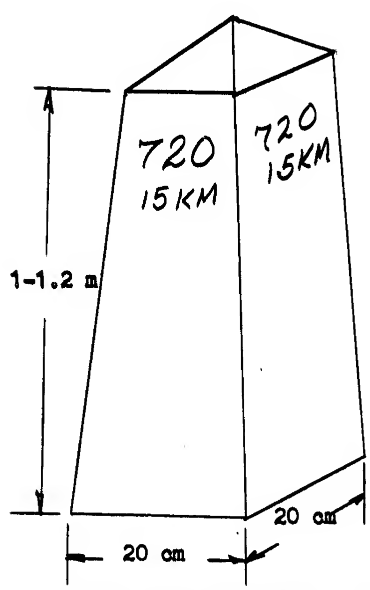

Figure 2 - Road Signs on Class II and III Roads

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